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ABSTRACT

This study examines various factors that influence school district spending and spending from locally raised taxes in Colorado and Minnesota. The factors include the levels of state and federal aid; the nature of the state general aid formula; local fiscal characteristics including the average market value of residential housing, the percent of the property tax base that is residential, and average household income; and various social and demographic characteristics including district size in terms of number of pupils, pupil growth rate, and factors that may be associated with the costs of education inputs. The report is divided into four primary sections with more technical material on the statistical equations placed in an appendix. Section 1 introduces the major issues. Section 2 briefly describes the history of school finance reform efforts in the two states studied. Section 3 summarizes the results of the statistical analysis and suggests how the aid formulas and various fiscal and other variables may influence school districts. Section 4 discusses how the results of such studies may be used in designing new state aid formulas that take into account district average income levels and other factors in formulating more sophisticated school finance simulation models. (Author/IRT)

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Fiscal Responses of School Districts

A Study of Two States — Colorado and Minnesota

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Report No. F78-3

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October 1978

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Foreword

This publication is one of a series of school finance policy studies that the National Institute of Education (NIE/DHEW) is supporting at the ECS Education Finance Center. It draws upon the center's technical assistance activities with state legislatures and governors, as well as its demonstrated knowledge in this important field. NIE's sponsorship of this work is based on our conviction that the major burden for school finance reform now falls on the nation's legislators and governors and that "goal oriented" research of this kind will lead to a more informed and productive debate on the subject of school finance reform.

The emergence of this key role for state legislators and governors is the product of a series of important and far-reaching court decisions. Beginning with the *Serrano* decision in California, a number of state courts have directed state legislators and governors to reconstruct the ways in which education resources are raised and distributed. In light of this state focus, it is particularly appropriate that ECS undertake research of this kind.

We at NIE hope this publication will serve the needs of legislators, governors, state and local education officials and interested citizens and thereby assist in the development and implementation of more equitable and effective systems of school finance.

Denis P. Doyle
Chief, School Finance
and Organization
National Institute of Education

Introduction

How do school districts react to levels of state and federal aid? How do they react to state equalization aid formulas and changes in these formulas? What economic and social characteristics may affect school district fiscal behavior in addition to the direct local tax base, which in most states is assessed value of taxable property per pupil? These are the primary questions addressed in this report.

In an era of school finance reform in which greater equalization of expenditures per pupil or available tax bases is taking place, an important issue is what determines how a school district responds to internal and external fiscal incentives and constraints. Without a significant equalization program at the state level, school district expenditures per pupil are primarily determined by the district property tax base per pupil. But, as the role of the state and federal governments becomes increasingly important in school finance, other elements gain a more significant place.

The present study examines various factors that influence school district spending and spending from locally raised taxes; Colorado and Minnesota are the states used for a case study. The factors include the levels of state and federal aid; the nature of the state general aid formula; local fiscal characteristics including the average market value of residential housing, the percent of the property tax base that is residential and average household income; and various social and demographic characteristics including district size in terms of number of pupils, pupil growth rate and factors that may be associated with the costs of education inputs.

This report is divided into four primary sections with more technical material on the statistical equations placed in an appendix. Section I introduces the major issues that analysts have dealt with in the school district fiscal behavior arena in the past few years. Recent contributions of major authors are reviewed. Section II briefly describes the history of school finance reform efforts in the two states chosen for detailed examination. Colorado and Minnesota were chosen both because of the desire to see how school district behavior may change with reform and because of the availability of the necessary detailed data. Section III summarizes the results of the statistical analysis and suggests how the aid formulas and various fiscal and

other variables may influence school districts in these and other states. Section IV discusses how the results of such studies may be used in designing new state aid formulas that take into account district average income levels and other factors in formulating more sophisticated school finance simulation models.

Over the course of many months, several people in Colorado and Minnesota provided a large array of data and background information on school finance legislation in their respective states.

In Colorado, Roger Black and Al Ickler of the Colorado Department of Education provided most of the necessary data for the analysis. Other data and technical assistance were provided by John Williams and Dave Wheelock of the Division of Property Taxation, Department of Local Affairs. Paul Turpin of the Department of Education was helpful in explaining the intricacies of the Colorado equalization formula. Deborah Galley of the Department of Education provided useful comments on recent aspects of Colorado school finance.

In Minnesota, Gary Farland of the Department of Education was the chief guide to gathering data from a diverse set of records. Klevan Downs and John Lalley of the Department of Revenue helped provide and interpret detailed data on property values by school district in the state. Sara Peterson of the Minnesota House of Representatives' Research Department was very helpful in providing background data on the history of reform and the current status of school finance in Minnesota.

These people, however, are not responsible for the analysis and interpretation of results contained in this report.

I. Recent Studies of School District Fiscal Response: A Brief Survey

Theoretical and statistical studies of the fiscal behavior of state and local governments have been a topic in applied public finance for some years. The expenditure and tax behavior of local governments with respect to such factors as state and federal aid, median family income and demographic characteristics have been studied at length.[1]

Sophisticated analyses of school district fiscal behavior have been relatively recent. These have been inspired in part, perhaps, by the new interest in school finance reform in the 1970s and particularly by the nature of some proposed and actual reforms. Of special interest have been the types of formulas based on percentage equalization or guaranteed tax bases. These formulas may be contrasted with the older, more familiar foundation types of state aid programs from an economic standpoint in that there are not only "income effects," but also "price effects" in the new aid formulas. That is, school districts are not only recipients of state government grants, equalizing or otherwise (over which the recipient districts exercise no direct control), but also may receive variable grants that depend in part on the property tax rates that the districts themselves decide to impose. Thus, districts receive not only specific amounts of "income" from the state, but also face a "price" for receiving additional amounts of state aid or making additional total expenditures.

For example, under a guaranteed tax base type of system, the following is a typical simple form:

State aid per pupil = (Property tax base per pupil that is guaranteed
× District's property tax rate)
− (District's actual property tax base per pupil
× District's property tax rate)

Thus, what the district receives from the state government as equalizing aid will depend not only on the tax base that is guaranteed by the state (presumably above the district's actual tax base), but also on the tax rate the district decides to set. State aid will rise when the

district sets a higher property tax rate, but this additional aid has a "price" (cost) since additional local tax dollars will be spent at the same time.

In contrast, the older foundation type of formula is set up such that only an "income effect" will exist. A simple formulation is the following:

State aid per pupil = (Foundation [minimum] level of support per pupil)
− (Required district property tax rate
× District's property tax base per pupil)

Thus, the amount of aid is outside the district's direct influence.[2] The district's expenditures will be influenced more as if it simply received a flat grant of additional "income."

As will be seen below, a few studies have examined the newer percentage equalizing or guaranteed tax base types of state aid formulas in terms of "matching rates" such as the additional local dollars that are necessary to obtain an additional dollar of state aid or to spend an additional dollar of combined state and local funds. Such a matching rate concept is like the familiar matching provisions of federal grants to state governments for highways or urban renewal.

Many other factors affect expenditure decisions by school districts in addition to the amounts of aid received from the state and federal goverment and the nature of the state aid formula. These include the residential or total property value per pupil in the district, the average income of its families and the percentage distribution of property value in terms of residential versus nonresidential. A few will be discussed briefly here and in somewhat more detail below as the arguments and findings of various authors are reviewed.

Although property value per pupil is the tax base for spending local funds in nearly every state in the nation, other local financial characteristics may affect decisions to spend. For example, differences in income per family for two districts that have equal property values per pupil may lead to differences in per pupil spending, even in a case where property tax bases have been highly "equalized" through state aid formulas that guarantee either minimum spending levels (foundation formulas) or guaranteed property tax bases. Similarly, it has been argued that for two otherwise equal districts, the district with a higher proportion of its property value in residential property will tend to spend less. The highly residential district's tendency to spend less may be because residential taxpayer-voters will see more of the tax burden of additional spending falling on them than in a community whose tax base is much more heavily commercial and industrial.

Feldstein (1975) and Ladd (1975; 1976) have made perhaps the most discussed contributions to the fiscal response literature in the past few years. These articles treat in detail both the issues of how state aid formulas with a "price" variable and how local fiscal capacity measures other than total assessed value of property per pupil may affect local expenditure decisions. Both used Massachusetts data around 1970 for their empirical tests.

Ladd (1975) sets up a statistical model of school district expenditure behavior based on several arguments. A major argument is that local taxpayer-voters will face a type of price relationship based on the relative proportion of residential property in the district. She describes how voters may take into account what they believe to be the extent of "shifting" of property taxes outside the district through the tax share paid directly by commercial and industrial property. All property taxes on residential property are assumed to be borne by residents — whether renters or owner-occupiers.

Another major issue addressed by Ladd is the division into three components of Massachusetts' state aid to local education. First, the Massachusetts aid formula in 1970 gave school aid in part on the basis of a matching rate (i.e., the number of state dollars received per local dollar raised), a rate that varies inversely with the per-pupil property tax base in a district. Other basic aid was nonmatching and there was also aid for categorical programs.

Finally, Ladd adds other economic and demographic factors to the statistical analysis, including median family income (U.S. Census — 1969 data), public and private school students in proportion to the district population, professional and related workers relative to the population and a measure of families with poverty-level income.

In all of the tests presented, nearly every variable is statistically significant and always of the expected sign, e.g., a one percent increase in the residential fraction of the property tax base may lead to between a 0.3 and 0.7 per cent decrease in total district spending per pupil. Similarly, an increase in the "price" embedded in the state aid formula will lead to a decrease in expenditures. Comparisons are made in Table 1 of some of the results of the authors surveyed.

Ladd (1976) further utilizes these results to indicate how a district's fiscal capacity can be measured on the basis of more than just its assessed value. She demonstrates how taxation of commercial and industrial property on a statewide rather than district basis in Massachusetts may lead to undesirable results: ". . . because of the positive correlation between the fraction of families in poverty and the

commercial/industrial nature of the community . . . if the goal of the policy shift is to reduce the variation in expenditures and to increase expenditures in low-income or low-wealth communities, removing the business component of the tax base with no compensating state aid would be counterproductive" (Ladd, 1976, p. 147).

Although they did not work together directly, Feldstein (1975) also bases his statistical work on Massachusetts data of around 1970. His statistical results are fairly similar, although estimates of the numerical relationships vary from Ladd's to some extent. But Feldstein's emphasis is even more on the problem of financing local education that neutralizes for the effects of local wealth, measured in various ways, without sacrificing the possibility of allowing local choice. Feldstein develops a theoretical model to produce a means of achieving "wealth neutrality," i.e., a condition where total spending per pupil by a district will not be related to a measure of local wealth that emphasizes property value, income and other variables. At the same time, he claims any desired level of spending by districts can be

Table 1

Selected Variables Analyzed in Recent Studies of School District Fiscal Response (Massachusetts) — Ranges of Estimated Elasticities for Total Expenditure Per-Pupil Differences[a]

	Total Expenditures Per Pupil		Local Expenditures Per Pupil
	Ladd	Feldstein	Grubb and Michelson
State Aid	0.03 to 0.04	−0.07 to 0.13	−0.01
Federal Aid	0.11	0.03 to 0.21	0.64
"Price" of State Aid	−0.59 to −0.49	−1.60 to −0.94	0.14
Measure of Property Value	0.24 to 0.29	0.10 to 0.36	0.40
Percent Residential Property	−0.72 to −0.31	−0.15 to 0.09	−0.07
Income	0.41 to 0.46	0.15 to 0.64	0.82
Pupil Growth	---	−0.53 to −0.23	----

[a] Elasticities are defined as the percent change in the dependent variable — here current expenditures per pupil — for a one-percent change in the independent (explanatory) variable.

Source: Helen F. Ladd, "Local Education Expenditures, Fiscal Capacity and the Composition of the Property Tax Base," *National Tax Journal* 28 (June 1975): 145-53; Martin S. Feldstein, "Wealth Neutrality and Local Choice in Public Education," *American Economic Review* 65 (March 1975): 75-89; W. Norton Grubb and Stephen Michelson, *States and Schools: The Political Economy of School Finance* (Lexington, Mass.: Lexington Books, 1974).

achieved by using the techniques he illustrates. Feldstein suggests that important elements missing from his analysis are measures of the price and quality of educational services — a point also made in effect by Ladd.[3]

Still another examination of school district spending — again using essentially the same Massachusetts data base as Ladd and Feldstein — is that of Grubb and Michelson (1974). Although Grubb and Michelson's publication date precedes that of Ladd and Feldstein, the work appears to have taken place at about the same time. Grubb and Michelson's discussion of the impact of different formulations of aid equations is more thorough in attempting to predict the direction of the effect of various factors. For example, they indicate that the effects of an increase in the state aid price variable may be unpredictable or ambiguous from an economic theory standpoint. That is, spending out of locally raised funds may go up or down for districts facing higher prices of aid, i.e., a lower state matching rate. Through different formulations and varying statistical techniques, Grubb and Michelson estimate a variety of impacts of the price and other variables. Again, Table 1 suggests the range of results obtained by these and the other authors.

Many other writers have begun to examine the complexities of how school districts behave in response to state aid formulas and local economic and social factors. Most have not examined explicity change over time. Basically a cross-section approach is utilized, i.e., a look at fiscal behavior across school districts for one particular year. A major question before both policy makers and policy analysts is how might school districts behave given a change in aid formulas. Given the problems of data availability, it is very difficult to develop any better answers than what these authors have given. But below, an attempt is made to examine data for two states on a "before" and "after" basis. Data are assembled for two states that have undergone some degree of change, one where a state has in fact greatly changed its basic aid formula from a foundation type to a modified guaranteed tax base type.

A major question is how similar the results would be for states other than Massachusetts in more recent years. Although other writers not discussed here have analyzed school district fiscal behavior in other states to some extent, the recognized basic works are mainly the above. But do other states operate in the same manner? And can the basic elements of state aid formulas be generalized to fit the frameworks developed by these authors? These and other issues are discussed in Sections II through IV.

II. A Brief History of Reform in Two Sample states: Colorado and Minnesota

In an attempt to test the work of previous authors and extend their efforts to more recent data sets and other states, two states were chosen for detailed data collection and analysis — Colorado (data for fiscal [calendar] years 1973 and 1975) and Minnesota (data for fiscal years 1972 and 1976). These two states were chosen after a survey of selected states for which the wide range of necessary basic data were available. The primary constraints on selecting states as it turned out were the availability of recent income data — necessarily based on state income tax returns where school district had been identified — and property tax base composition data. It would appear that several states are collecting income data by school district these days and have good detailed data on property tax base composition by school district. Certain states for which all the necessary data probably were available were already being studied for related purposes under National Institute of Education and foundation grants.

Colorado

In 1973, the Colorado Legislature implemented a significant change in the state school aid distribution method that first took effect in 1973 (Colorado school districts' fiscal year is the calendar year).[4] As of 1973, the Colorado aid formula was a modified foundation program. The foundation level of expenditure was $518 per pupil with a basic local qualifying tax effort of 17 mills (per $1,000 of assessed valuation). However, if the 17 mills times the district assessed valuation exceeded $250 per pupil, then higher required local expenditures per pupil to qualify for aid went into effect in steps. All districts received some state aid in 1973, varying from around $40 per pupil to $470 per pupil.

The new law that first went into effect in 1974 was essentially a modified guaranteed tax base formula with a limited range of applicability. Furthermore, limitations on the rates of revenue per pupil increase were imposed such that districts spending less than $1,000 per pupil were allowed to increase revenues at rates of from 8 to 12 percent per year; but all districts reaching or above $1,000 were

allowed revenue per pupil increases of only 7 percent per year. Exceptions to the latter limitations were allowed only by the State School Budget Review Board, which was in charge of establishing each district's Authorized Revenue Base (ARB), i.e., the allowable revenues per pupil, or by local referendum.

The guaranteed tax base took the form of a guaranteed amount of dollars per mill per pupil. In 1975, the guarantee rate was $27 per mill of local tax rate per pupil. In effect, this set a guaranteed tax base of $27,000 per pupil. The mean assessed value (*not* adjusted for differing actual county property assessment ratios, as Colorado does not perform such an adjustment in its aid distribution process) was $22,527 in 1975. However, there was a "minimum guarantee" amount of aid per mill per pupil of $9. Hence, a district that had greater than $18,000 per pupil in assessed valuation ($27,000-$9,000), would receive $9 of state aid per mill of local taxes levied per pupil no matter how high its assessed value per pupil. If the formula had no such "minimum guarantee," then districts with valuations above $27,000 would have received no state equalization payments; and a "recapture" provision would actually have taken local "excess" revenues back to the state from high-wealth districts for redistribution.

Thus, Colorado exhibits a pattern of giving at least some aid to all districts, although apparently not through formally "grandfathering" aid per pupil levels for districts when change occurs. Still when reform took place, no district appears to have received less state aid per pupil than in 1973.

Measuring degrees of equalization achieved by state aid formulas is a complex task. In fact, there are two basic standards of judging equalization in school finance. One is the degree of equality or inequality in expenditures per pupil across the state.[5] Of course, it may be argued that this standard should be modified further by geographic cost differences and costs due to special pupil needs.[6] The other standard is "fiscal neutrality," defined by the degree of relationship of the district tax base per pupil and per pupil expenditures. In its simplest form, fiscal neutrality is identified with assessed value per pupil, although the discussion in Section I introduces broader views of what should be included under measures of local fiscal capacity. In any case, the basic focuses of the two standards differ: the expenditure equality standard focuses on pupils, while the fiscal neutrality standard is more oriented toward equality in treatment of (property) taxpayers across school districts in a state.

In 1973, the coefficient of variation (standard deviation divided by the mean) in expenditures per pupil in Colorado was 0.40. A measure

of fiscal neutrality is the correlation between expenditures per pupil and the value of property per pupil, which was 0.89 for assessed value and 0.80 for market value. In 1975, the second year for the new formula, the coefficient of variation had fallen somewhat to 0.56. The correlation coefficients of expenditures and property values had fallen to 0.81 for assessed value and 0.69 for market value in per pupil terms. Thus, some degree of further equalization had taken place with implementation of the new formula by both standards of equalization.[6]

No matter what the presumed fairness of the Colorado aid formula, it does appear to have a "price" element in that districts are able to affect the amount of state aid received by varying their local property tax rates. But the price variable takes two forms, one for lower property value districts and one for higher property value districts, due to the "minimum guarantee." This and other factors create difficulty in relating research for other states to the Colorado case, as is indicated in Section III and the Appendix B.

Minnesota

In 1971, school finance underwent a political and legal crisis in Minnesota. In fact, perhaps only by a twist in the timing of political and court decisions did the *Serrano* decision in California, declaring that state's school finance system unconstitutional, become the most famous in a series of court cases on school finance.[7]

School finance inequities were one of the major campaign issues in the 1970 Minnesota gubernatorial campaign. The eventual victor, Wendall Anderson, proposed significant changes in January 1971. In the same year a court suit charging that the existing school finance system was unconstitutional was brought in federal court. The federal judge declined to dismiss the suit in October 1971, a month after the California Supreme Court decision in *Serrano*. In November, after a veto by Governor Anderson of an earlier bill and a special session, a major school finance and tax relief bill was passed and signed. The court case was eventually dropped.

The basic Minnesota aid formula was changed very little. Minnesota continues to use a basic foundation type of formula. But the foundation level guaranteed was raised by 50 percent from fiscal 1971 to fiscal 1972 (although late in the latter year) — from $404 per pupil to $600 per pupil. However, there was not a required local tax rate at the outset of the reform process. In 1973-74, incentives were designed to get relatively low-spending districts to catch up to the full foundation level by 1978-79. Thus, in 1976, only around half the districts actually had a formula allowance of the full amount of the foundation

level in effect at that time, $900 per pupil. In 1976 average expenditures were around $1,000 per pupil out of local revenues and state equalization aid; total operating expenditures per pupil from all sources of funds averaged around $1,400 per pupil.

Important elements of the reform were an attempt to control total school district resources through the imposition of "levy limits," while increasing direct property tax relief such as the agricultural and homestead property tax credits. In fact, a 30-mill tax rate in the foundation formula became a limitation that districts could not exceed — with some important exceptions. The exceptions included a provision that permitted high expenditure districts to levy in excess of 30 mills in order to avoid cutting back on school services — the so-called "grandfather levy." And although school boards could not increase the mill levy, voter overrides were permitted. As of 1975, 40 districts (out of approximately 440) had voted such overrides.

Comparisons between 1972 (the transition year to the new formula level and limitations) and 1976 can be made as were done for Colorado above. The coefficients of variation in total expenditures per pupil, a measure of degree of expenditure equality, were 0.16 in 1972 and 0.16 in 1976; the variation was less than for Colorado in both years, but did not change with the reform effort. The correlations of expenditures per pupil with assessed value per pupil and market value per pupil in 1972 were 0.15 and 0.13, respectively. The same correlations in 1976 were 0.07 and 0.05, respectively. Thus, Minnesota began reform with a much less serious equalization problem than Colorado and has reduced that problem still further.

The Minnesota approach, of course, has been to emphasize expenditure equality at the same time as achieving a large degree of fiscal neutrality with respect to property tax burdens. The reform movement has had as a dominant theme property tax reduction by direct and indirect means, as well as an equalization of resources for pupils across the state.

Both Colorado and Minnesota have undergone reform in the past few years. After the initial change, the elements of the two formulas have been modified, usually to provide even more aid to districts. Whether the changes have been sufficient to withstand state court tests — one being underway at present in Colorado — as to sufficient degrees of equity are questions that remain.

In any case, the two states provide interesting cases for testing school district responses to important formula changes. The Colorado case in particular presents a challenge for formulating a price or variable cost sharing component to compare with the results of other writers

discussed in Section I. The next section and its supporting appendix addresses this and related issues of fiscal response.

III. Fiscal Response in Colorado and Minnesota

As implied above, "fiscal response" relates to district expenditure behavior in response to variations in both internal and external fiscal factors affecting the district. Internal factors include the district's own financial/economic characteristics. External factors include amounts of and conditions on aid receipts from state and federal governments. In addition, there are other constraints increasingly being imposed on districts by state and federal governments that complicate greatly both theoretical and statistical analysis of behavior. Both Colorado and Minnesota have imposed variations of local expenditure and tax limitations. Particularly in the case of Colorado, this makes the statistical analysis very difficult to formulate in order that such conditions are fully and correctly taken into account. In fact many of the results of the analysis of the "price variable" for Colorado do not conform well with basic expectations and the results discussed in Section I for Massachusetts.

The following discussion of the statistical results for Colorado and Minnesota is based mainly on the equations that are described in detail in the Appendix A. Various sets of variables are discussed in turn. Both the direct dollar and the elasticity coefficients for the two states are compared.

State and Federal Aid

Of major interest to many policy makers is how school districts will tend to react to differences in levels of state and federal aid when there are no direct matching provisions. For state equalization aid, the response across Colorado districts in 1973 in total spending is estimated to be a *negative* $1.38 for each $1 of additional aid per pupil. Across districts, on the average, a $1 difference in state equalization aid is negatively associated with approximately a $1.40 difference in total expenditures per pupil. These results are confounded, perhaps, in a cross-sectional analysis by the fact that expenditures exhibited a positive and high correlation with assessed valuation; equalization aid, a strong negative correlation. A more plausible result is that for Minnesota, where total spending per pupil appears to increase by $0.28 to $0.41 for each additional $1 of state aid per pupil in each of the years 1972 and 1976.

The results for local spending conform to these estimates for total spending. Spending out of local (mainly property) taxes is lower with higher state aid across districts, other factors held constant. Minnesota districts on average use an extra state equalization dollar to reduce local taxes by $0.55 to $0.72. The results for Colorado are much stronger, although so high as to be somewhat suspect.[8]

The preceding results are based on cross-section (single period of time) analysis for several different years. The advantage of having at least two different years for each state — particularly during a "reform" effort — is that it allows at least some investigation of movement over time. The cross-section results for districts may or may not give a good picture of what is likely to occur over the course of several years.

In Minnesota, an analysis differencing expenditure levels and explanatory factors between 1972 and 1976 indicates that districts will spend an additional $0.49 out of an increase of $1 in state equalization aid. This suggests that the property tax reduction impact may be somewhat lower over time than the effect that could be inferred from the cross-section results. Due to the change in equalization aid formula type in Colorado, similar differencing for total equalization aid was not performed; the fiscal price subsection that follows treats the Colorado case.

For state categorical aid, the results for the two states are much more similar. A $1 difference in categorical aid across districts in both years examined for both states results in between $1.07 and $1.90 in additional total spending. The results of the separate examination of locally financed expenditures conforms to these observations. The components of categorical aid vary between the two states and for the two years, of course, ranging from additional aid for disadvantaged children to aid for transportation services. Again, the explicit differencing analysis for change between the two years indicates that there may be some substitution over time of state categorical aid for local property taxes not indicated by the cross-section analysis: total expenditure increases for $1 changes in aid over the period ranged from $0.80 to $0.92.

The results for federal aid of all types are mixed. In each of the two years in Colorado, federal aid appears to stimulate extra local spending — or at least not substitute for it. The change-over-time result suggests that $1 of additional federal aid stimulates an additional $0.46 of local spending. In Minnesota, there appears to be substitution of some of the federal dollars for local dollars over time, with an important shift in this relationship taking place between 1972 and 1976. Although there are federal requirements that federal funds not be substituted for local funds, districts over time may

effectively be able to do this by not undertaking programs, from their own funds, for which federal aid is available.

The ranges of elasticity estimates for the cross-section analyses of the two states for the two years are shown in Table 2 for the major fiscal variables analyzed. Comparisons can be made with the results of writers discussed in Section I as summarized in Table 1. Responses of total expenditures to one percent increases in state equalization aid and state categorical aid range from −0.15 to 0.15 percent. These estimates are only slightly outside the range found for Massachusetts by Ladd and Feldstein. The largest local expenditures decrease, −0.40, was much greater (in absolute value) than found by Grubb and Michelson. The percent response to federal aid, 0.02 to 0.11, was essentially within the range obtained by Ladd and Feldstein. Grubb and Michelson's local expenditure response was much larger than found for Colorado and Minnesota in the present study.

Table 2

Selected Variables Analyzed in Colorado and Minnesota Studies of School District Response — Ranges of Estimated Elasticities for Expenditure Per-Pupil Differences[a]

	Total Expenditures Per Pupil	Local Expenditures Per Pupil
State Equalization Aid	−0.15 to 0.13	−0.40 to −0.31
State Categorical Aid	0.09 to 0.15	0.05 to 0.11
Federal Aid	0.02 to 0.11	0.06 to 0.07
Price Variable (Colorado only)	0.20	3.25
Residential Market Value	−0.07 to 0.12	0.10 to 0.54
Percent Residential Assessed Value	−0.16 to 0.00	−0.54 to 0.00
Adjusted Gross Income	0.17 to 0.29	0.11 to 0.41
Pupil Growth Ratio	0.12 to 0.28	−0.20 to 0.41

[a] Elasticities are defined as the percent change in the dependent variable — here current expenditures per pupil — given a one-percent change in the independent (explanatory) variable.

Source: See Tables A-5 to A-8 in Appendix A.

Fiscal Price

There are alternative ways to conceive of the potential effects of a guaranteed tax base type of state equalization aid formula as discussed in Section I above. In any case, a guaranteed tax base will mean that at least for those districts with property values per pupil below

the guarantee level, an extra dollar of total spending per pupil will mean less than one dollar of additional local taxes. Thus, there is a sharing of additional expenditures between the state government and the district.

Although there are variations, most writers have specified what is called here the "fiscal price" in terms of a ratio. That ratio is often local expenditures (revenues) divided by the sum of state equalization aid through the guaranteed tax base formula and the locally financed expenditures. Thus, this "price" or sharing ratio will range in theory from zero (no local contribution) to one (no state equalization aid through the GTB formula).

The fiscal price in Colorado turns out to be much more complicated when derived from the explicit and implicit algebra contained in the equalization aid formula as it existed in 1975. Not only is the fiscal price variable facing any given district a direct algebraic function of the district's assessed value per pupil, but also additional aid flows to the district on a one-year lag basis when the district decides to spend more. Details of the derivation of the Colorado fiscal price variable are given in Appendix B.

Several constraints have been added to the simple guaranteed tax base formulas, as was indicated in Section II. There are actually two groups of districts, those above and those below the so-called "minimum guarantee." A further complication that makes statistical estimation of fiscal price effects very difficult is the imposition of revenue growth limitations as discussed in Section II. Furthermore, if a district were allowed to increase its authorized revenue base beyond the given percentage restriction, all the additional expenditures had to come from local taxes. However, this additional spending above the basic increase became incorporated in the next year's authorized revenue base and thus was subject to sharing in state aid in the usual manner of the basic guarantee in the succeeding year.

The basic theory suggests that the fiscal price variable, correctly formulated, should be negatively related to total spending and either positively or negatively related to locally financed spending. Although the above-mentioned complications were taken into account to at least some degree in the statistical analysis, the results do not conform well to theoretical expectations nor to the results of Feldstein, Ladd and Grubb and Michelson for Massachusetts. The net result from the cross-section tests for Colorado in 1975 is a statistically significant *positive* relationship between total spending and the fiscal price. For example, a 0.1 higher fiscal price implies approxi-

mately a $172 increase on average in total spending per pupil by a district with approximately a $370 increase in locally financed spending. Elasticity results are similarly positive.

In the first difference (change over time) analysis, 1.0 (the effective fiscal price of additional spending in 1973) was subtracted from the calculated fiscal price in 1975 (always less than 1.0). The former price is 1.0 since all extra spending by a district under the old foundation plan came out of locally financed revenues. In this case, the conclusion of a positive, not negative, relationship still appears to hold.

In sum, it is difficult to establish relationships for the fiscal price variable in Colorado that conform to the simple theoretical prediction and the statistical results for Massachusetts in 1970. However, the existence of expenditure constraints that can be varied upon petition and result in sharing in succeeding years (but not the current year) complicate greatly the simple analysis and statistical interpretation and testing. Hence, it would have been difficult to predict the fiscal responses of school districts in Colorado in moving to the new formula after 1973 when so many side conditions were imposed.

Similar frustrations have arisen for Carroll (1978) in recent work on Michigan in attempting to get a price relationship similar to that of Feldstein, *et al.* In discussion of Carroll's efforts with the present authors, there are several conclusions that might be drawn in this area: (1) it is becoming clear that we cannot generalize from the Massachusetts case — in fact, a highly constrained fiscal price variable may be more the rule than the exception; (2) it takes time for school district decision makers to learn how a new finance system operates and to respond as economic theory might suggest; (3) school district decision makers will not find it politically feasible to cut back on expenditures just because there is a low matching rate; (4) school districts cannot change expenditure patterns — either upwards or downwards — very quickly.

Residential Property Value

Two aspects of residential property value were examined for Colorado and Minnesota — average market value of residential property per pupil and the percentage of the total assessed valuation of property in the district that is residential. Economic reasoning suggests that increases in the former will lead to greater expenditures per pupil in a district while increases in the latter will tend to result in decreases in expenditure. The statistical results generally conform to these expectations.

A $1,000 increase in residential market value per pupil appears to

lead to between $1 and $7 in additional expenditures per pupil across districts; the differencing analysis gives similar results. In Table 2, the range of elasticities for total expenditures per pupil is shown as −0.07 to 0.12 with the predominance of results on the positive side. And for locally financed expenditures, the results are stronger in terms of elasticities, the range being from 0.10 to 0.54.

The statistically significant results for the percent residential assessed value variable are all negative. A one-percentage point increase in percent residential may lead to roughly a $2 to $4 decrease in expenditure per pupil — generally out of locally financed funds.

It should be noted that although total residential property per pupil was converted to a market value estimate, it appears to be appropriate to examine percent residential in assessed value terms. In most states assessment practices vary widely, both among districts and within districts, despite state government efforts to achieve better conformity of valuations. Thus, in terms of relative share of the local tax burden, one should focus on the share of the assessed valuation rather than market valuation of residential property. On the other hand, voter-taxpayers generally will think in terms of their property tax payments relative to the market values of their dwellings rather than assessed valuations.

In comparison with the authors cited in Table 1, the results for Colorado and Minnesota are somewhat lower for percent residential in absolute value terms.

Income

The measure of income used in the current study is different from that used by the authors cited above. The most recent U.S. Census estimates of median family and unrelated individual income for school districts is for 1969. Thus, most writers have focused on fiscal years close to that date. In the present study, adjusted gross income per return based on state tax return data was employed. This measure was chosen since it is the only income measure produced in a few states for school districts that is reasonably current. Also, although adjusted gross income excludes many types of income included in the Census definition, especially transfer payments like welfare and social security, the "per return" denominator may come fairly close to matching up with "per household" that the Census focuses upon.

The upshot is that analysis of school district behavior relative to average income levels in districts as well as inclusion of an "income factor" in a state aid formula requires year-to-year collection of income data. The easiest way to do this appears to be through the

state (or possibly federal) income tax system wherein the school district would have to be identified on the income tax form. Of course, since many taxpayers may not have accurate information on the school district in which they reside, a monitoring effort is probably necessary at the state revenue collection department.[9]

Each additional $1 of adjusted gross income per return in a district appears to lead to between $0.01 and $0.04 in additional expenditures per pupil. The results for Colorado alone, however, are not consistently positive nor statistically significant. Most of the additional expenditure appears to take place out of locally financed funds, although in a guaranteed tax base state with true flexibility in gaining additional state aid upon raising the district property tax rate, it would appear that there would be interaction between the tax rate and the district income level. The latter should lead to greater increases in total spending than in locally financed spending alone. However, Colorado does not fit into this simple framework.

Elasticity estimates (see Table 2) range from around 0.1 to 0.4, within the range found by other writers for Massachusetts in 1970 (see Table 1).

Other Variables Examined

A variety of other potential explanatory factors in addition to those discussed above were examined, as can be seen in Appendix A, Tables A-1 through A-10. These variables were examined for their own sakes and to standardize for a variety of factors thought to affect school district spending. These include: the pupil growth rate during the time period analyzed; pupil density; district size in terms of pupils; percent minority pupils; districts per square mile in the district's region (an attempt to get at competition for teachers); price of agricultural land and highest teacher salary (in Colorado only, an attempt to get a crude measure of education cost variations across districts). Some of the results for these variables will be summarized briefly here.

Pupil growth appears to have a positive impact on expenditures per pupil in most instances in the cross-section analysis but is significantly negative in the differencing analysis. The result from the analysis over time is support for the argument that declining enrollments have not tended to decrease expenditures per pupil due to lags in ability to adjust total expenditures. Both states have special programs to aid high growth and/or decline districts, which can distort the underlying numerical results, however.

Higher pupil density generally has a positive effect on expenditures

across districts at a point in time. The pupil size variables, including the square of pupil size, are included in an attempt to take some account of possible economies or diseconomies of scale, although a strict analysis of economies of scale requires focusing explicitly on a cost function analysis. The results suggest that there may exist "U-shaped" cost curves where average costs may fall to a minimum at some size and rise thereafter.

Percent minority pupils has mixed effects in the regression equations. In the earlier years in both states, the effect on expenditures was negative, while it tended to be positive in the later years, in Minnesota. The change-over-time results suggest that increasing percentages of minority pupils are associated with increasing expenditures.

The last three variables examined (districts per square mile in the region of the district, the average price of agricultural land in the region of the district and the highest teacher salary) show both positive and negative, statistical significance and insignificance, in different equations.[10]

IV. Conclusions and Policy Implications

The results of the above analysis hopefully are interesting both for what they indicate and what they do not resolve. For example, it is likely that school districts will tend to use at least some general aid to reduce locally funded spending, i.e., reduce local property taxes, if this is permitted. In fact, even if the legislative intent is full use of additional aid for education spending, district decision makers often will have ways of circumventing this policy unless there are very tight restrictions. Thus, school finance aid increases can generally be counted upon as effecting some property tax relief, one of the often-stated goals of school finance reform in addition to or even considered more important than equalization of expenditures or greater fiscal neutrality.

On the other hand, the frustrating results for the fiscal price variable suggest that more work needs to be done to understand just how guaranteed tax base programs operate in practice across the states. The Colorado case can be looked at in perhaps two ways: (1) further work must be done in formulating the statistical relationships so that the "correct" negative relationship of total spending per pupil and fiscal price is demonstrated, vs. (2) in reality, there is no true fiscal price in operation in Colorado — and many other GTB states — that allows districts to choose their levels of expenditure along a path that is fiscally neutral at least with respect to property value per pupil alone. The latter point can be extended to argue that we perhaps need to investigate the various rationales for the restrictions imposed by legislatures and the variety of ways in which they are carried out.[11]

The direct technical uses of the results of fiscal response analysis will be discussed in turn. Some thoughts on other issues that are relevant are summarized in a concluding subsection.

Modifications in State General Aid Formulas

The concept of fiscal neutrality lately has received much attention in the school finance literature. The initial concept may have been focused primarily on children, but it has come to be associated more with a type of equal treatment of property taxpayers across school districts.[12] Various writers have pointed out that if a simple standard of property-wealth-per-pupil neutrality is utilized in a state aid for-

mula (i.e., a simple sharing or guaranteed tax base formula) then school district expenditures per pupil will tend to vary widely across a state. A basic reason for this is that factors other than assessed value of property per pupil will influence school district spending, a point that is demonstrated in the statistical analysis in this report.[13] Hence, even if a state guarantees completely equal effective property tax bases to all districts in the state, a low average *income* district will tend to spend less (choose a lower property tax rate) than a high average income district. Thus, legislators may wish to neutralize for other elements of fiscal capacity than simply the direct local tax base, assessed value of property.

The following will illustrate in a rather simplified manner how additional fiscal variables and the coefficients developed from statistical analysis as presented earlier might be used to neutralize for such other factors. The present example will simply focus on the income relationship, i.e., development of a so-called "income factor" in an aid formula, to illustrate the procedure. A more complete, though complicated, approach is demonstrated by Feldstein.

For purposes of illustration, assume that the equations in Appendix A can be reduced to the following elementary form:

Total Expenditures per Pupil =
A + B × Income per Return + C × State Aid per Pupil.

We can then set a hypothetical goal that every district in the state should be able to spend equal amounts per pupil, if they choose to do so. We can then consider any two districts, call them District 1 and District 2, and assume that they make equal expenditures per pupil (have equal Total Expenditures Per Pupil). What state aid differentials could make up for the actual income differentials of these two districts?

We can write out our assumption ("goal") of equal revenues per pupil and then do a little algebraic manipulation to come up with a simple income factor for modifying state aid.

Total Expenditures per Pupil in District 1 = Total Expenditures per Pupil in District 2

Then substituting on each side for the explanatory equation written above, using the actual levels of income in each district and using the desired level of aid for each district to neutralize for the income differences, we can write:

A + B × State Aid per Pupil in Distict 1 + C × Income per Return in District 1 =
A + B × State Aid per Pupil in District 2 + C × Income per Return in District 2

This equation can be solved for the "aid differential" to yield:

(State Aid per Pupil in District 1 − State Aid per Pupil in District 2) = (C ÷ B) × (Income per Return in District 2) − Income per Return in District 1)

That is, the "income factor" in this case is (C ÷ B), the regression coefficient for income per return divided by the regression coefficient for state aid per pupil in explaining expenditures per pupil.

This result is used in the following manner to get aid differential results for each district in the state. Take District 1 income per return to be the state average across districts. Then District 2 is any particular district in the state. If District 2 has an income per return below the state average, then the income differential is negative. Multiplying this differential by (C ÷ B), which is positive, yields a negative value for the hypothetical difference between state aid in the first district (the "average district") and the second, below-average-income district. But this means that the second district should get this much *more* aid per pupil than the hypothetical average district. The aid differential in the above equation could be positive, but this is interpreted as meaning that this much aid per pupil would be taken out of the aid calculated normally for an above-average-income district on the basis of district property value per pupil.

To illustrate specifically, we can borrow from the results for Minnesota in 1976 (see Table A-2) where the income response coefficient is $0.029 and the state equalization aid response coefficient is $0.280. Dividing the former by the latter yields a factor of 0.104. This factor times the difference in average district income from, say, the state average income, would yield an increase or decrease in aid per pupil to be applied to normally calculated district aid.

It must be emphasized that the above calculation has been done for illustrative purposes only, since the case presented applies more strictly to a state with a foundation type of aid formula where an additional income factor might be desired. A more extensive calculation based on the fiscal price variable relationships would be necessary in a guaranteed tax base formula. Again, the interested reader is referred to the technical discussion in Feldstein. In any case, similar calculations can be made for any one or a combination of the various fiscal variables explored in this report, including market value of residential property per pupil and percent residential assessed value.

In concept, "all" socioeconomic and demographic factors that explain expenditures per pupil could be incorporated in an adjustment of the state aid formula, although most formal discussions have tended to focus on the economic variables thought to comprise "fiscal capacity";

elements such as cost differentials and declining enrollments could be compensated for in other direct or indirect ways, as discussed, for example by Chambers, Odden and Vincent (1976) and Odden and Vincent (1976). However, if the real goal is to achieve near equality in expenditures per pupil, perhaps adjusted for differential costs, pupil need, etc., then a direct approach by the state would be technically much simpler than highly complicated adjustments to an aid formula while attempting to continue what some refer to as "local fiscal control".

Local fiscal control can run a spectrum from belief that the state should play very little role in adjusting for local fiscal capacity or expenditure differences to belief that fiscal capacity should be greatly equalized along several measures including income and tax base composition as well as assessed value. But most of those advocating local expenditure control would agree that local tastes, unconfined by local fiscal capacity, should still determine variations in expenditures per pupil.

Again, if expenditure equality is the real goal, it can be achieved in a technical fashion much more directly. The politics of achieving this goal may be another matter, since there may remain divergent opinions over the appropriateness of this goal.[14]

Improvements in School Finance Simulations

School finance simulations vary widely in their structures and uses. Some simulations developed by particular states are limited to variations in levels of support within the basic parameters of their existing school finance programs. Other simulations are much more general and can suggest the outcomes of a wide variety of alternative formulas from foundation to guaranteed tax bases, with and without pupil weightings, including caps on expenditure increases, etc. Nearly all show the details of what aid flows would go to each school district in the state and thus have political as well as analytical uses.

However, most simulations are limited in the underlying school district behavioral models that are employed for predicting what will happen to an individual school district's aid and total expenditure levels as aid formulas are changed. A typical example is where two or three alternative responses of school districts are available for use in the simulation (e.g., that school districts will use all additional state aid to increase education expenditures, half the aid is used for additional spending while half goes to local property tax relief, etc.).

The analysis done for this report is suggestive of better ways to formulate the underlying behavioral models of school finance simu-

lations. For example, at the most elementary level, we see that at least some of general aid will tend to go to property tax reductions. On the other hand, additional state and federal aid for categorical programs can stimulate some additional spending, probably in many instances because of required local spending or support activities to complement the additional aid flows.

There are at least two ways to go in using the findings of this and related reports on fiscal response coefficients. One may take the middle range of alternative responses or the average and use these coefficients as new parameters of the standard simulation models. Alternatively, one could perform analyses similar to that done here for whatever state is to be simulated. Then the particular coefficients obtained, where feasible, could be applied within that state's simulation model. As we have seen, it may be that Colorado districts on average behaved differently under a foundation program than Minnesota districts.

A more complex simulation model could be developed that takes into account the variety of other fiscal capacity variables analyzed herein, such as district income per return, percent residential assessed value and pupil density. In the equations in Appendix A that are constructed in "log" form (see Tables A-5 to A-8), the basic relationship among the explanatory variables actually is assumed to be in a multiplicative form. That is, the absolute level of spending by a district is based not on a sum of absolute levels of explanatory variables, each multiplied by its coefficient, but by a product of these explanatory variables each to a power, the elasticity coefficient.[15] This means, in effect, that other factors besides the amount of additional state aid will affect how a district may choose to use that additional state aid (i.e., how much to use for additional spending and how much to use for property tax relief).

An example may help show how this phenomenon may operate. Drawing on the elasticity estimates for Minnesota in 1972 in Table A-6, we could form the simple relationship of expenditures per pupil to state equalization aid and income alone. If we solve from the log form as illustrated in the preceding footnote, we could obtain:

$$\text{Expenditures per Pupil} = 8.2\ (\text{State Equalization Aid})^{0.1}\ (\text{Income})^{0.3}$$

Now if we assume that two districts receive equal amounts of state aid (e.g., their assessed values of property per pupil are equal as are all other formula-related factors) at an assumed level of $700 per pupil, then their spending will differ in direct relation to their income differences. For example, a district with average income of $10,000

will spend $250 while a district with average income of $15,000 will spend $283. That is, the impact or use of aid — including increases of aid — will vary with other factors existing in the district. In this instance, the higher income district will use relatively more of the state aid, other things equal, for increased education spending than the low-income district. This makes economic sense, since each district will tend to look at the flow of general state aid as a grant of income, and the poorer district will tend to spend less of the increment on education than on other items. That is, more of the state aid will be used to finance property tax relief, which can then be spent on private sector goods and services or perhaps other government services.

The use of the results of the statistical analysis to build better simulations based on observed actual behavior obviously can become quite complicated and must be left to the expert simulation modelers. Still, this relatively simple illustration shows how the impact of aid programs can differ, sometimes significantly, from the usual simple assumptions about what the average school district will do when new formulas are imposed and additional aid is given. At the same time, in building more sophisticated simulation models, there is a tradeoff between the costs of constructing such a simulation and benefits of the possible increased accuracy of its predictions.

Longer-Run Issues

One of the more complex issues of school finance reform, including especially major changes in school aid formulas and aid allocations to different districts, is the long-run adjustments in locations of firms and individuals and accompanying property demand. Some of the measures of district fiscal capacity that are analyzed here for their impacts on fiscal responses will themselves change over time in response not only to basic economic and social forces, but also to changes in the aid formulas themselves. In property value terms, to put it another way, increases and decreases in local property taxes together with increases and decreases in school spending will tend to be "capitalized."

To illustrate, assume that a new school aid formula is introduced that neutralizes fiscal capacity both for property value per-pupil differences and income differences among school districts. In addition, assume there is a recapture and/or expenditure limitation provision that forces very high spending districts to cut back on school services. The forces from both the tax side and the expenditure side on a school district that initially is fortunate enough to have both high property value per pupil and high income per family (in most states these are not highly correlated) would be such as to reduce property values in

the district. A reform of this nature will tend to raise property taxes in the high-wealth district — or at least reduce them in adjacent low-wealth districts. Thus, one attractive element of the high-wealth district will be reduced and competitive forces will tend to reduce the price of housing in this district. Similarly, a reduction of local government services — here from the very important education sector — with no accompanying property tax reduction will tend to reduce the value of the home in the high-wealth district in comparison with a home in another school district that retains the same characteristics (e.g., size, convenience, view), except for the modified flow of services. The numerical values of these changes and the time period over which they take place are very difficult to sort out, but the direction of the effect is rather clear.

Changes in demand for property in alternative districts can also arise through the addition of the income factor. The advantages of living in a higher income community for those who desire greater education spending, in this example, will also be reduced. There are usually homeowners "on the margin" who chose this district over another because of its advantages in terms of education taxing and spending and who will now consider moving to another location if these advantages disappear.

Overall, this process will take a long time. And the school aid formula, if it really is allowed to operate without important "grandfather clauses" or expenditure and tax restrictions, will continually reallocate aid flows from year to year in part in response to these changes in property values, average income levels and other relevant variables induced by the initial reform. It likely will be a few years before a new relatively settled (equilibrium) situation is reached, particularly if the reform is a major one.

Inman (1975) is one author who explicitly speculates on the impacts that reform of school finance formulas may have on some of the above fiscal variables themselves. In a rather complicated general equilibrium framework of economic theory, he considers how a fuller analysis would include the costs of locally producing education, household and business location decisions, impacts on land values and further responses of school districts to changes in such variables. It is difficult to determine just how these changes will work themselves out except in a general theoretical way.

For purposes of the present type of fiscal analysis, this suggests that the relationships of district education spending to the various economic and demographic variables examined will probably change over time with important school finance reforms. Hence, if the coefficients from the estimated behavioral relationships are themselves

influencing the aid formula, there will be a feedback process in operation. The formula — or a simulation model — may have to be modified from time to time to take into account these new relationships, although the numerical levels of the coefficient changes may turn out to be so small as to make this a minor empirical issue.

Final Conclusions

Despite the difficulties in sorting out the intricacies of fiscal responses of school districts, some conclusions are becoming relatively clear. In the states examined, school district decision makers on average opt for reducing local property taxes perhaps by 50 cents or more on the dollar of additional state general aid when they are free to do so. Hence, reform that gives more general aid to most all districts will tend to result in property tax relief as well as increased school spending. It is likely that somewhat more tax reduction will take place in communities that are poorer in both property value per pupil and average income. Even state and federal categorical aid may have substitution effects on local spending.

On the other hand, it is extremely difficult to throw much light on the effect of an unrestrained "fiscal price variable" response — in Colorado and many other states, such local choice does not really exist. In fact, the 1975 Colorado case may be more representative of present and future school finance reforms than is the 1970 Massachusetts case.

Average income of the district's residents does make a difference. And market value of housing per pupil is an important variable that may reflect more of families' "permanent" income than yearly actual income levels. Likewise the percentage of property value that is residential does have a negative influence on spending, probably reflecting the reduced actual and perceived ability of voter-taxpayers to shift property tax burdens to locally based businesses and nonresidents.

The future direction of work involves both better specification of the underlying behavioral equations, including perhaps the addition of both short-run and long-run interactions with other sectors of the economy. And better expenditure model results are likely to occur when we have estimates available for the costs of producing education services across districts in a state.[17]

Appendix A
Statistical Equations and Data Sources

The theoretical developments and statistical procedures utilized by economists analyzing fiscal responses of school districts have grown complex indeed. In the analysis presented here, the work of other writers is built upon, but relatively simple statistical techniques are used. However, these techniques may appear mysterious indeed to the layperson who is not very familiar with formal statistical analysis.

Although the underlying mathematics and computer manipulations involved in "multiple regression analysis" — the statistical approach employed here — are complex, the basic interpretation of the resulting equations can be relatively straightforward.

A basic rationale of formal statistical procedures as used here is to sort out apparent relationships of different factors, to sort out those associations that are more by chance from those where there may be true causal relationships. We would also like to know something about the orders of magnitude of these relationships that appears to be other than by chance.

Statistical Equations

Tables A-1 through A-10 present the basic equations upon which the discussion in Section III is based. The equations are alternative formulations of the relationships between total or locally financed educational spending per pupil by essentially all districts in each of the two states. Tables A-1 and A-2 indicate the relationships found for total spending per pupil in the two states and Tables A-3 and A-4 are for spending out of local revenues, almost entirely from property taxes. These first four sets of equations are in "linear" form. Thus, the numerical coefficients can be interpreted as in the following example. In Table A-1, the coefficient for Colorado in 1973 for Federal Aid is 1.682 — and is statistically significant at the 95 percent level of confidence, i.e., we can be fairly sure the true relationship is in the neighborhood of this value. (See the footnotes at the bottom of each table.) Thus $1 additional federal aid for a school district — assuming all other influences identified in the equation are the same — would

on average have resulted in an additional $1.68 in total spending by the district. Total federal revenue per pupil for Colorado school districts in 1973 averaged $53. Hence, an "average" school district receiving this average amount of federal aid might have been predicted to have spent an additional $89 per pupil. Thus, additional total spending beyond the grant money appears to have been encouraged. A supporting result is found in Table A-3 for federal aid: a $1 variation in federal aid appears to have led to a $0.68 increase in locally financed expenditures.

The "constant term" in the equations is rather hypothetical. It suggests the amount that would have been spent by a school district even if the values of all the explanatory variables in the equations were zero.

Tables A-5 through A-8 parallel the previous four tables. However, most of the variables, including the dependent variables, total or locally financed current expenditures per pupil, are in natural logarithm form. Taking the logs of the variables before running the multiple regression results in a different interpretation of the coefficients from the previous straight linear form. The coefficients are now the "elasticities" of response. For example, the result for federal aid for Colorado in 1973 (see Table A-5) suggests that a 1.0-percent change in federal aid per pupil tends to result in approximately a 0.036-percent change in total spending per pupil. Estimating the equations in elasticity form can make comparisons across states and across time a bit easier since units of measurement, mean levels of the variables, basic inflationary effects and other factors may not need to be taken into account.

At least one other numerical relationship may need explanation. The "R^2" in the bottom row of each table indicates the percentage of the variation in the dependent variable, expenditures, that is explained by the above explanatory variables that have been included in the equation. Thus, in Table A-1, around 83 percent of the variation in total expenditures per pupil by school districts in Colorado in 1973 could be explained by those factors examined here.

As suggested earlier, there are a variety of analytical problems that remain in formulating some of the variables and their relationships, including especially the price variable for Colorado, and in testing the relationships by more sophisticated statistical techniques. Many of the issues remain to be clarified.

Table A-1

Total Current Expenditures Per Pupil Fiscal Response Coefficients for Colorado, 1973 and 1975 — Linear Equation Form [a]

Variables	1973	1975
Constant Term ($/pupil)	991.069	−147.134
State Equalization Aid ($/pupil)	−1.383	---
	(5.447)	---
Price Variable	---	1,689,270
	---	(4.175)
Authorized Revenue Base Increase [b]	---	130.620
	---	(1.860)
Below Authorized Revenue Base [c]	---	−99.623
	---	(− 0.965)
State Categorical Aid ($/pupil)	1.601	1.801
	(7.352)	(14.711)
Federal Aid ($/pupil)	1.682	0.867
	(12.842)	(2.640)
Residential Market Value ($/pupil)	0.003	0.001
	(5.316)	(3.006)
Percent Residential Assessed Value	−4.117	−1.951
	(4.161)	(1.676)
Adjusted Gross Income ($/return)	0.014	0.009
	(1.233)	(0.749)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	353.138	155.703
	(2.733)	(0.970)
Density (pupils/square mile)	1.219	0.985
	(0.822)	(0.599)
Pupils (1000s)	14.421	8.946
	(1.956)	(0.970)
Pupils Squared (1,000,000s)	−0.165	−0.103
	(1.449)	(0.791)
Percent Minority Pupils	−2.522	−1.187
	(2.637)	(0.997)
Districts Per Square Mile in Region (1000s)	29.660	30.180
	(2.773)	(2.387)
Price of Agricultural Land ($/acre)	0.029	0.021
	(0.656)	(0.563)
Highest Teacher Salary ($)	−0.023	−0.018
	(2.066)	(1.420)
R^2	0.83	0.82

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was increased, zero otherwise.

[c] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was not reached, zero otherwise.

Table A-2

Total Current Expenditures Per Pupil Fiscal Response Coefficients for Minnesota, 1972 and 1976 — Linear Equation Form [a]

Variables	1972	1976
Constant Term ($/pupil)	359.751	660.394
State Equalization Aid ($/pupil)	0.411	0.280
	(4.878)	(3.893)
State Categorical Aid ($/pupil)	1.325	1.068
	(14.571)	(16.283)
Federal Aid ($/pupil)	1.301	0.887
	(9.701)	(10.074)
Residential Market Value ($/pupil)	0.007	0.001
	(3.742)	(0.940)
Percent Residential Assessed Value	−4.054	−2.131
	(5.280)	(2.197)
Adjusted Gross Income ($/return)	0.043	0.029
	(5.230)	(5.261)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	14.001	25.843
	(0.238)	(0.412)
Density (pupils/square mile)	0.169	0.314
	(3.100)	(4.703)
Pupils (1000s)	6.692	5.503
	(1.746)	(1.134)
Pupils Squared (1,000,000s)	−0.125	−0.067
	(1.768)	(0.614)
Voter Override Attempted, 1973-76 (dummy variable: 1-yes; 0-no)	---	34.050
	---	(1.944)
Percent Minority Pupils	−3.677	2.492
	(3.223)	(1.812)
Districts Per Square Mile in Region (1000s)	−9.337	−8.028
	(4.072)	(3.128)
Price of Agricultural Land ($/acre)	−0.010	0.017
	(0.261)	(0.679)
R^2	0.50	0.66

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

Table A-3

Locally Financed Current Expenditures Per Pupil Fiscal Response Coefficients for Colorado, 1973 and 1975 — Linear Equation Form [a]

Variables	1973	1975
Constant Term ($/pupil)	991.979	[NA]
State Equalization Aid ($/pupil)	−2.382	---
	(9.382)	---
Price Variable	---	3,541.170
	---	(9.132)
Authorized Revenue Base Increase [b]	---	166.011
	---	(2.466)
Below Authorized Revenue Base [c]	---	0.336
	---	(0.003)
State Categorical Aid ($/pupil)	0.601	0.860
	(2.762)	(7.334)
Federal Aid ($/pupil)	0.682	−0.103
	(5.206)	(0.328)
Residential Market Value ($/pupil)	0.003	0.001
	(5.316)	(4.099)
Percent Residential Assessed Value	−4.119	−1.850
	(4.164)	(−1.658)
Adjusted Gross Income ($/return)	0.014	0.011
	(1.230)	(0.929)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	352.672	93.182
	(2.729)	(0.635)
Density (pupils/square mile)	1.213	0.182
	(0.818	(0.101)
Pupils (1000s)	14.436	6.708
	(1.958)	(0.759)
Pupils Squared (1,000,000s)	−0.166	−0.077
	(1.453)	(0.615)
Percent Minority Pupils	−2.523	−0.544
	(2.639)	(0.476)
Districts Per Square Mile in Region (1000s)	29.700	25.460
	(2.776)	(2.101)
Price of Agricultural Land ($/acre)	0.029	0.018
	(0.660)	(0.508)
Highest Teacher Salary ($)	−0.023	−0.019
	(2.070)	(1.505)
R^2	0.79	0.78

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was increased, zero otherwise.

[c] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was not reached, zero otherwise.

Table A-4

Locally Financed Current Expenditures Per Pupil Fiscal Response Coefficients for Minnesota, 1972 and 1976 — Linear Equation Form [a]

Variables	1972	1976
Constant Term ($/pupil)	352.418	657.931
State Equalization Aid ($/pupil)	−0.551	−0.720
	(6.546)	(10.008)
State Categorical Aid ($/pupil)	0.306	0.065
	(3.376)	(0.995)
Federal Aid ($/pupil)	0.243	−0.094
	(1.819)	(1.068)
Residential Market Value ($/pupil)	0.007	0.001
	(4.068)	(0.951)
Percent Residential Assessed Value	−4.469	−2.120
	(5.843)	(2.185)
Adjusted Gross Income ($/return)	0.044	0.029
	(5.347)	(5.282)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	12.370	25.963
	(0.212)	(0.414)
Density (pupils/square mile)	0.170	0.313
	(3.120)	(4.690)
Pupils (1000s)	7.002	5.491
	(1.836)	(1.132)
Pupils Squared (1,000,000s)	−0.133	−0.068
	(1.889)	(0.627)
Voter Override Attempted 1973-76 (dummy variable; 1-yes; 0-no)	---	33.791
	---	(1.929)
Percent Minority Pupils	−2.254	2.463
	(1.985)	(1.791)
Districts Per Square Mile in Region (1000s)	−9.106	−8.007
	(3.991)	(3.119)
Price of Agricultural Land ($/acre)	−0.009	0.017
	(0.254)	(0.690)
R^2	0.47	0.63

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

Table A-5

Total Current Expenditures Per Pupil Fiscal Response Coefficients for Colorado, 1973 and 1975 — Log Linear (Elasticity) Equation Form [a]

Variables	1973	1975
Constant Term ($/pupil)	5.46	3.022
State Equalization Aid ($/pupil)	−0.149	---
	(3.581)	---
Price Variable	---	0.201
	---	(0.902)
Authorized Revenue Base Increase [b]	---	−0.193
	---	(−2.721)
Below Authorized Revenue Base [c]	---	0.130
	---	(0.986)
State Categorical Aid ($/pupil)	0.092	0.111
	(3.979)	(6.591)
Federal Aid ($/pupil)	0.036	0.022
	(4.213)	(2.622)
Residential Market Value ($/pupil)	0.111	0.117
	(4.274)	(4.244)
Percent Residential Assessed Value	−0.144	−0.155
	(4.424)	(−4.479)
Adjusted Gross Income ($/return)	−0.040	−0.056
	(0.797)	(1.112)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	0.283	0.124
	(2.472)	(1.355)
Density (pupils/square mile)	0.031	0.026
	(2.055)	(1.855)
Pupils (1000s)	−0.079	−0.126
	(3.405)	(5.770)
Percent Minority Pupils	−0.002	−0.001
	(3.284)	(1.835)
Districts Per Square Mile in Region (1000s)	0.045	0.055
	(1.656)	(2.112)
Price of Agricultural Land ($/acre)	0.040	0.057
	(1.767)	(2.548)
Highest Teacher Salary ($)	0.179	0.330
	(0.119)	(2.980)
R^2	0.76	0.76

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was increased, zero otherwise.

[c] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was not reached, zero otherwise.

Table A-6

Total Current Expenditures Per Pupil Fiscal Response Coefficients for Minnesota, 1972 and 1976 — Log Linear (Elasticity) Equation Form [a]

Variables	1972	1976
Constant Term ($/pupil)	2.139	5.533
State Equalization Aid ($/pupil)	0.130	−0.029
	(3.230)	(1.602)
State Categorical Aid ($/pupil)	0.150	0.143
	(10.873)	(9.676)
Federal Aid ($/pupil)	0.110	0.088
	(8.177)	(7.321)
Residential Market Value ($/pupil)	0.045	−0.065
	(1.929)	(3.733)
Percent Residential Assessed Value	−0.088	0.005
	(3.956)	(0.318)
Adjusted Gross Income ($/return)	0.286	0.168
	(5.365)	(5.151)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	0.053	−0.042
	(0.929)	(0.925)
Density (pupils/square mile)	0.033	0.040
	(3.497)	(5.262)
Pupils (1000s)	−0.024	−0.003
	(2.270)	(0.327)
Voter Override Attempted, 1973-76	---	0.022
(dummy variable: 1-yes; 0-no)	---	(1.738)
Percent Minority Pupils	0.003	0.004
	(2.495)	(4.486)
Districts Per Square Mile in Region (1000s)	−0.037	−0.056
	(1.755)	(3.286)
Price of Agricultural Land ($/acre)	−0.044	−0.023
	(2.096)	(1.361)
R^2	0.42	0.51

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

Table A-7

Locally Financed Current Expenditures Per Pupil Fiscal Response Coefficients for Colorado, 1973 and 1975 — Log Linear (Elasticity) Equation Form [a]

Variables	1973	1975
Constant Term ($/pupil)	1.536	5.437
State Equalization Aid ($/pupil)	−0.348	---
	(5.540)	---
Price Variable	---	3.248
	---	(12.397)
Authorized Revenue Base Increase [b]	---	−0.451
	---	(5.407)
Below Authorized Revenue Base [c]	---	0.053
	---	(0.340)
State Categorical Aid ($/pupil)	0.078	0.046
	(2.244)	(2.287)
Federal Aid ($/pupil)	−0.008	−0.001
	(0.006)	(0.108)
Residential Market Value ($/pupil)	0.256	0.214
	(6.584)	(6.568)
Percent Residential Assessed Value	−0.300	−0.273
	(6.122)	(−6.720)
Adjusted Gross Income ($/return)	0.111	−0.025
	(1.469)	(−0.410)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	0.412	0.252
	(2.390)	(2.334)
Density (pupils/square mile)	0.039	0.034
	(1.750)	(2.057)
Pupils (1000s)	−0.074	−0.076
	(2.122)	(2.943)
Percent Minority Pupils	−0.006	−0.002
	(4.900)	(2.697)
Districts Per Square Mile in Region (1000s)	0.016	−0.004
	(0.391)	(0.125)
Price of Agricultural Land ($/acre)	0.064	0.067
	(1.881)	(2.543)
Highest Teacher Salary ($)	0.255	0.054
	(1.421)	(0.411)
R^2	0.81	0.91

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was increased, zero otherwise.

[c] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was not reached, zero otherwise.

Table A-8

Locally Financed Current Expenditures Per Pupil Fiscal Response Coefficients for Minnesota, 1972 and 1976 — Log Linear (Elasticity) Equation Form [a]

Variables	1972	1976
Constant Term ($/pupil)	−0.092	−1.445
State Equalization Aid ($/pupil)	−0.402	−0.313
	(3.291)	(5.183)
State Categorical Aid ($/pupil)	0.047	0.018
	(1.132)	(0.372)
Federal Aid ($/pupil)	0.072	0.061
	(1.758)	(1.518)
Residential Market Value ($/pupil)	0.461	0.542
	(6.440)	(9.363)
Percent Residential Assessed Value	−0.486	−0.540
	(7.176)	(9.505)
Adjusted Gross Income ($/return)	0.408	0.302
	(2.518)	(2.782)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year)	−0.042	−0.203
	(0.247)	(1.342)
Density (pupils/square mile)	0.060	0.081
	(2.098)	(3.151)
Pupils (1000s)	−0.034	0.013
	(1.080)	(0.477)
Voter Override Attempted 1972-75 (dummy variable: 1-yes; 0-no)	---	0.104
	---	(2.463)
Percent Minority Pupils	−0.012	0.004
	(3.579)	(1.374)
Districts Per Square Mile in Region (1000s)	−0.092	−0.133
	(1.431)	(2.341)
Price of Agricultural Land ($/acre)	−0.110	0.041
	(1.722)	(0.729)
R^2	0.51	0.63

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

Table A-9

Change in Current Expenditures Per Pupil Fiscal Response Coefficients for Colorado, 1975 less 1973 — Linear Equation Form [a]

Variables	1975-1973	
	Total	Locally Financed
Constant Term ($/pupil)	682.585	760.007
Price Variable	421.748	1,079.181
	(2.000)	(5.288)
Authorized Revenue Base Increase [b]	−158.679	−148.772
	(1.919)	(−1.859)
Below Authorized Revenue Base [c]	278.637	120.989
	(1.761)	(0.790)
State Categorical Aid ($/pupil)	0.847	−0.021
	(7.882)	(0.202)
Federal Aid ($/pupil)	1.457	0.459
	(10.344)	(3.370)
Residential Market Value ($/pupil)	0.000	0.001
	(0.281)	(1.205)
Percent Residential Assessed Value [d]	−0.194	0.565
	(0.299)	(0.901)
Adjusted Gross Income ($/return)	−0.014	−0.010
	(1.021)	(0.706)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year) [d]	−267.129	−396.648
	(2.678)	(4.109)
Density (pupils/square mile)	−1.951	9.790
	(0.163)	(0.844)
Pupils (1000s)	2.136	−14.414
	(0.073)	(0.510)
Percent Minority Pupils	4.712	3.577
	(0.961)	(0.754)
Districts Per Square Mile in Region (1000s) [d]	−4.082	−6.193
	(0.558)	(0.875)
Price of Agricultural Land ($/acre) [d]	0.007	−0.003
	(0.241)	(0.092)
R^2	0.53	0.38

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was increased, zero otherwise.

[c] Dummy variable times price variable where dummy variable equals one when Authorized Revenue Base was not reached, zero otherwise.

[d] 1975 Value, i.e., not a change variable.

Table A-10

Change in Current Expenditures Per Pupil Fiscal Response Coefficients for Minnesota, 1976 less 1972 — Linear Equation Form [a]

Variables	1976-1972	
	Total	Locally Financed
Constant Term ($/pupil)	279.264	284.990
State Equalization Aid ($/pupil)	0.493	−0.513
	(7.477)	(7.826)
State Categorical Aid ($/pupil)	0.800	−0.212
	(12.237)	(3.263)
Federal Aid ($/pupil)	0.812	−0.196
	(7.795)	(1.890)
Residential Market Value ($/pupil)	0.003	0.003
	(1.739)	(1.805)
Percent Residential Assessed Value	−2.718	−2.706
	(1.812)	(1.811)
Adjusted Gross Income ($/return)	0.010	0.010
	(1.324)	(1.390)
Pupil Growth Ratio (pupils in 2nd year/ pupils in 1st year) [b]	−155.732	−159.440
	(2.500)	(2.571)
Density (pupils/square mile)	−0.390	−0.384
	(0.892)	(0.883)
Pupils (1000s)	−9.972	−9.846
	(0.830)	(0.823)
Voter Override Attempted, 1973-76 (dummy variable: 1-yes; 0-no)[b]	−6.422	−8.319
	(0.401)	(0.522)
Percent Minority Pupils	4.259	4.443
	(0.858)	(0.899)
Districts Per Square Mile in Region (1000s) [b]	−1.088	−1.165
	(0.510)	(0.549)
Price of Agricultural Land ($/acre)	0.070	0.071
	(1.351)	(1.375)
R^2	0.46	0.25

[a] t-statistics are in parentheses below the regression coefficients. Variables of the predicted sign are statistically significant at the 90-percent level of confidence when the t-statistics are greater than 1.30 and at the 95-percent level when greater than 1.67.

[b] 1976 Value, i.e., not a change variable.

Data Sources

Colorado. For the state of Colorado most of the data used in the analysis were obtained directly from the Department of Education. These data included the following variables: total current expenditures, locally financed current expenditures, state equalization aid, state categorical aid, federal aid, adjusted gross income, pupils, percent minority pupils, square miles of school districts and teacher salary data. "Expenditure" data are actually tax and general aid revenues for current operating expenses; revenue data are generally used in such studies to avoid major difficulties in sorting out accounting procedures on expenditures and to attain greater comparability within and among states. Local tax administrators had provided data directly to the department on the composition of the district's tax base.

Another large component of the data was provided by the Colorado Division of Property Taxation. These data included: total assessed valuation by district, market value ratios and assessors' market value by county. Various assumptions were necessary to allocate property value data to districts lying in more than one county. It became necessary to use only 1975 breakdowns to determine residential versus nonresidential percentages.

Other data were derived from several Census publications. The districts and counties that lie within economic regions (defined by the Census as relatively homogeneous subdivisions of states) are from: U.S. Bureau of the Census, *State Economic Areas*, 1970 Census of Population, (Washington, D.C.: Government Printing Office, 1970), Appendix A. Square miles of these areas were derived from U.S. Bureau of the Census, *County and City Data Book, 1972* (Washington, D.C.: Government Printing Office, 1972), Table 2, Item 1-15. A final variable, the price of agricultural land, was obtained from U.S. Bureau of the Census, *1974 Census of Agriculture*, County Summary Data (Washington, D.C.: Government Printing Office, 1975), Table 1.

Minnesota. The data for the state of Minnesota were obtained from several publications and computer tapes provided by the Minnesota Department of Education. The variables included: total current expenditures, locally financed current expenditures, state equalization aid, state categorical aid, federal aid, pupils, square miles of school districts, percent minority pupils and voter override attempted, 1973-76.

Income, property values and sales ratio data were obtained from the Department of Revenue, Local Government Aids and Analysis Divi-

sion. Income per return was calculated from data in: *The Minnesota State Individual Income Tax*, Bulletin No. 39 (1972) and Bulletin No. 46 (1975), Minnesota Department of Revenue, Table 40 (1972), Table 38 (1975). Data on sales ratios for 1975 were obtained from: *1975 School District Assessed Values*, Minnesota Department of Revenue, Equalization and Review Committee, Report No. 1. For 1972 the data are obtained from: *1972 Construction of School District Ratios*, Minnesota Department of Revenue, Local Government Aids and Analysis Division. Due to the classified property system in Minnesota, where different types of property are legally assessed at diverse percentages of market value, a variety of computations were necessary to arrive at estimates of market value. Census data as for Colorado were also utilized.

Appendix B
Derivation of Colorado Fiscal Price Variable

With the Finance Reform Act of 1973, Colorado put into effect a modified guaranteed tax base formula. The range of assessed values over which the state would "match" expenditures in inverse relation to assessed value was given an upper limit, but a minimum dollar guarantee per mill, per pupil is distributed even to the districts above this level of wealth. Also, the amount of expenditure increases allowed from year to year were set in an inverse relation to the *level* of expenditures per pupil prevailing in 1973. Those districts spending *less* than $1,000 per pupil could increase expenditures at rates from 8 to 12 percent per year; but all districts spending *at* or *above* $1,000 were allowed increases of only seven percent per year. These limits can be surpassed only by the State School Budget Review Board, or vote of the district. These restrictions feed into the present analysis in two ways, the definition of the price variable of the Colorado formula and the separation of districts into groups to allow for expenditure limit behavior.

The importance of the above expenditure limits is that they define, in any one year, a school district's Authorized Revenue Base (ARB), which in conjunction with the guaranteed tax base ($27,000 per pupil in 1975) for that year gives the mill levy on which aid to that district is based. The *actual* levy of the district does not affect the aid they receive this year — there is no "matching" of funds. Yet, the level of local revenues raised this year will *affect* aid received by the district *next* year. Any matching of state to local funds must be viewed intertemporally in Colorado and a price variable from this formula must include this dynamic aspect.

An intertemporal price variable can be derived from a general algebraic expression for aid per pupil distributed by the guaranteed tax base program in Colorado:

$$A_i = (Gt_e - B_i t_e)$$

where G = state guaranteed valuation per pupil

B_i = assessed valuation of the i^{th} school district

and $t_e = (e'_i/G)\ (r_i)$

where e'_i = expenditures by the i^{th} school district last year
r_i = allowable growth factor for expenditures from last year for i^{th} school district

But t_s is *not* free to vary indiscriminately across disticts; rather, its variation is set by the state in relation to the ARB of the district. Rewriting the above expression and substituting for t_s (no longer expressed in mills):

$$A_i = (G - B_i)\ (e'_i/G)\ (r_i)$$
$$= (1 - B_i/G)\ (e'_i)\ (r_i)$$

and recognizing that expenditures last year contain a local plus state aid component:

$$A_i = (1 - B_i/G)\ (L'_i + A'_i)\ (r_i)$$

where L'_i = locally financed expenditures last year for i^{th} school district
A'_i = state equalization aid received last year for i^{th} school district

To put this formula into the framework of Ladd and Feldstein's price definition, the question that needs to be answered is: What is the relationship of aid dollars and local revenue dollars? That is, what additional dollars are forthcoming from the state as local revenues are changed? An answer is found by differentiating the aid expression with respect to the local revenue variable:

$$\frac{\delta A_i}{\delta L'_i} = \left(1 - \frac{B_i}{G}\right)\ (r_i)$$

The intertemporal price variable then becomes:

$$P_i = \frac{1}{1 + D\left(\frac{\delta A_i}{\delta L'_i}\right)} = \frac{1}{1 + D\left[\left(1 - \frac{B_i}{G}\right)(r_i)\right]}$$

where D = a discount factor.

The discount factor is needed to take into account the year lag between the action of the district and the receipt of aid. It is assumed that this discount factor is (1/1.05). The price of education expenditures, then, in any given year is less than a dollar of local revenue in that year, by the amount of state to local matching dictated from last year's tax levy.

As mentioned, the Colorado finance scheme imposed expenditure limits in conjunction with its reform act. These limits, if effective,

may actually nullify any "price response" that would otherwise be observed. Such local choice may not really exist in Colorado and other GTB states and the effect of an unrestrained "fiscal price" response is simply not possible.

On the other hand, there are districts that, after review board or district vote approval, behave differently from the dictates of the formula, by levying either above or below the prescribed mill levy. Data on these districts allow for the definition of dummy variables used in the equations. The hypothesis is that these districts by this very behavior are responding to the price variable.

Footnotes

[1]For a survey of the literature of some years back and a contribution to specification of alternative formulations, see, for example, Campbell and Sacks (1967). The literature has grown increasingly sophisticated in the professional economics journals since the publication of this work.

[2]That essentially all state school aid formulas attempting to equalize for property value per pupil differentials across districts are special cases of a general formulation has been illustrated. For example, see Jargowsky, Moskowitz and Simkin (1977).

[3]Work in progress for the California Department of Education by the present authors and Professor Jay G. Chambers, Stanford University, will attempt to incorporate cost indices in a study of this type.

[4]The following description is derived in part from documents kindly provided by Roger Black, Colorado Department of Education.

[5]A recent discussion of alternative measures is found in Berne (1977).

[6]Whether the new Colorado formula will stand up under state constitutional requirements is currently being tested through a suit filed in the Colorado state court system.

[7]This section draws in part on the description of Minnesota school finance reform from 1971 to 1975 in Ostrem and Smith (1976). Helpful comments were made by Sara Peterson.

[8]James N. Fox, National Institute of Education, has pointed out that the very high negative relationship of equalization aid to spending in Colorado may be a statistical aberration due to the low-degree of equalization, i.e., the high correlation between local property value and spending (per pupil).

[9]In states where such data on adjusted gross income per return by school districts are collected, there is usually much debate over the accuracy of these data. In Missouri, where the Education Commission of the States undertook a major school finance study, it was found that adjusted gross income per return for 1975 had a correlation of 0.75 with median family for 1969 across the over 500 districts in the state. This correlation seems quite high given the six-year time difference and the different income definition. Thus, using the adjusted gross income per return measure would seem to be satisfactory. Furthermore, given the major problems with property assessment practices in Missouri and most other states, this income measure is probably as accurate as the assessed property value per pupil measure used in school aid formulas already.

[10]For a discussion of cost indices and the use of such explanatory factors as

the price of agricultural land, see, for example, Chambers and Vincent (1978).

[11]For a general discussion of recent tax rate and expenditure limitations in various states, see Wilken and Callahan (1977).

[12]For a seminal work that has tended to be associated more with the fiscal neutrality doctrine, despite some of the personal views of the authors see Coons, *et al.* (1975).

[13]This point has been discussed in part under a concept of "*ex ante* vs. *ex post*" fiscal neutrality in Friedman (1977).

[14]The present authors and their colleagues at the Education Commission of the States have been fascinated by the technical direction that political compromise taken both in states where ECS has consulted on aid formula reform and other states that have undertaken reform. There has been a tendency to combine a basic foundation formula — a nod in the direction of expenditure equality — and a guaranteed tax base formula for possible expenditures above the foundation level — a wave at fiscal neutrality and a nod toward local fiscal control. Examples include Missouri, South Dakota and California, all in 1977.

[15]When an equation is statistically tested in the form in Tables A-5 to A-8, $\ell n\ Y = \ell n\ A + B\ \ell n\ x + C\ \ell n\ Z$, it means that (by taking "antilogs") the underlying equation can be written as $Y = AX^B Z^C$. Thus, the impact on Y of additional X depends not only on its coefficient (elasticity), B, but also on the level of Z (as well as the coefficients A and C).

[16]For a discussion and empirical estimation of these effects, see, for example Oates (1969).

[17]The present authors and Professor Jay G. Chambers, Stanford University, are currently developing both cost-of-education indices and estimates of fiscal response and capacity in California for the state department of education. These results should be available by Fall 1978.

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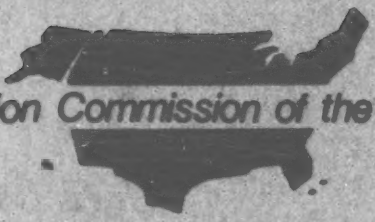

Education Commission of the States

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